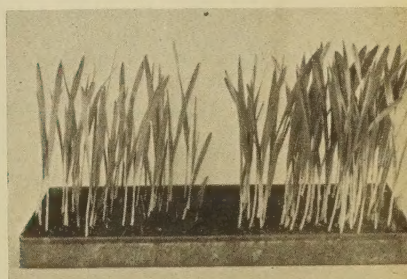
JUNE, 1936 Extension Circular 226

SMALL GRAIN DISEASES in IOWA

and THEIR CONTROL



Soil germination of treated and untreated barley infected with the scab organism. Untreated are shown on the left. One hundred seeds of each were planted. Note the strong germination of the treated seed.

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Small Grain Diseases in Iowa and Their Control

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The cost of producing small grains in Iowa is increased by a group of parasitic diseases, the most important of which are stripe and root rot of barley and smuts, rusts, blights, and ergot of barley, wheat, oats and rye. These diseases increase production costs by reducing the yield, quality and feeding value of the grain. Each of the above diseases is caused by a microscopic organism, but each organism is affected in its attack by such environmental factors as temperature, moisture and the condition of the host plants; hence the prevalence of, and losses caused by diseases vary from year to year.

It is the purpose of this circular to describe and illustrate those small grain diseases caused by parasites, which are partially or entirely seed-borne and, in so far as possible, prescribe methods of control. Inasmuch as rusts are not transmitted by seed and have been described separately in other station and extension publications, they will not be treated in this circular.

BARLEY DISEASES

By far the major portion of the small grain acreage in Iowa is planted to oats, but within the past 10 years farmers have been interested in barley production for the following reasons:

1. Barley has come to be recognized as a summer feed substitute for corn.
2. A cash crop substitute for oats has been needed.
3. Smooth-awned varieties of barley have been developed.
4. There has been an increased demand for malting barley together with market premiums for high grades.

Farmers who have grown barley continuously over a long period have secured greater net returns per acre than from oats but 1 year out of 4 or 5 a scab epidemic has usually developed with the result that quality has been sufficiently reduced to discourage any further increase in acreage.

The most important barley diseases from the standpoint of reduction in yield and quality are scab, Helminthosporium blight, stripe, ergot, loose smut, covered smut and bacterial blight. Stripe and loose smut have little or no effect on quality. Scab and Helminthosporium blight are the major factors in so far as quality is concerned.

Scab

Scab is undoubtedly one of the most important factors in the production of barley because it not only reduces the yield

but renders infected grain inferior for either feed or malting. The scab organism attacks barley, wheat, oats, rye, corn and many wild grasses. Symptoms of scab on barley may be detected on the seed, seedling and head. Infected seed may or may not be shriveled; the glumes are brown or dark, and the kernel proper is usually shriveled and discolored. Shriveled kernels are always light in weight. If field infection comes late, infected kernels may show no shriveling. On moist blotters infected seeds usually have a web of pink or white mold attached which is nothing more than the organism growing on the seed. Infected seed, when planted in the field, may germinate but the plants never develop beyond the seedling stage because of seedling blight. The severity of this latter trouble is dependent on the degree of infection and on environmental conditions. Early planting and seed treatment will help to decrease this type of injury. Symptoms of scab on seeds and seedlings are shown in fig. 1.

Scab on the head appears in various forms. Individual kernels may be attacked either at the base, middle or upper part of the head, and in each case the affected part shrivels and fails to develop. In other instances, several spikelets at the base or tip of the head may be attacked, causing arrested development. When the attack comes early at the basal kernels, the remainder of the head does not develop because of lack of food and water. Infection takes place from the time of pollination until the grain is in the hard dough stage. Moderate temperatures and high humidity following the period of ripening or harvesting encourage further development of the scab organism which results in the formation of small black fruiting bodies on the chaff of each kernel. The scab organism lives also on old stubble of small grains and grasses and on corn stalks, all of which serve as

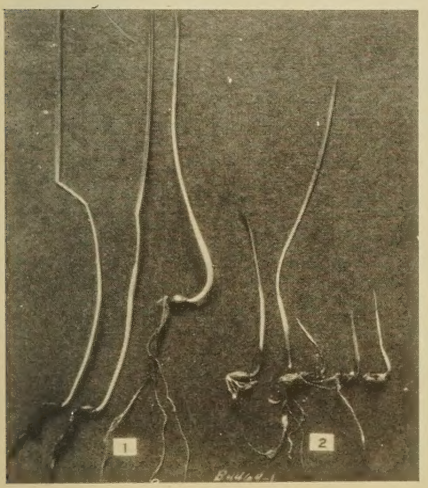

Fig. 1. Healthy and scab-diseased barley seedlings. Left—healthy, right—diseased.

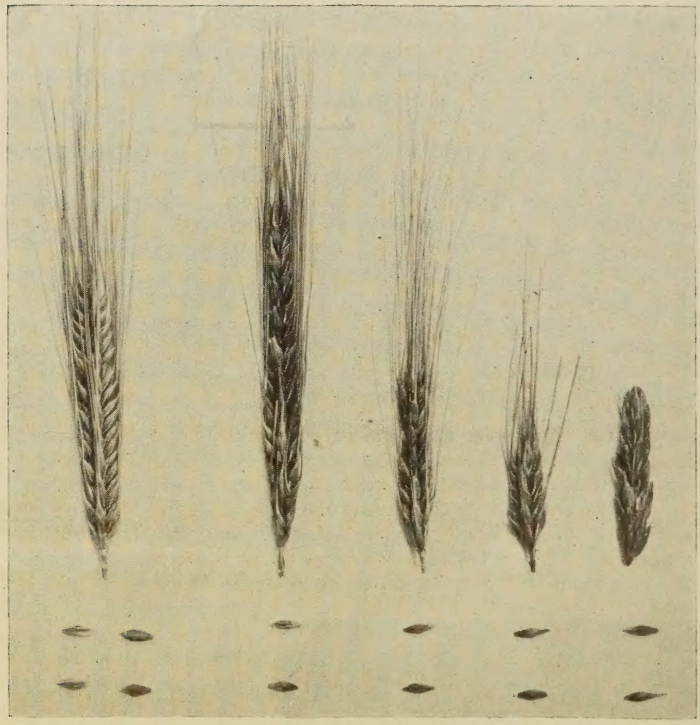

Fig. 2. Head on left—healthy barley. Four heads on right show scab disease.

a source of infection to the developing heads. The scab disease was especially severe in 1928, in 1932 and in 1935. Symptoms of scab on barley heads are shown in fig. 2.

Effect of scab organisms on feeding and malting.—Feeding experiments in Indiana, Illinois, Iowa, Wisconsin and Europe show that the organisms which cause scab are poisonous to hogs and man, and render infected grain of little value as feed for chickens. The organisms, when fed either in pure culture or in the form of naturally-infected barley, cause vomiting in hogs to such an extent that the affected animals refuse to eat and rapidly lose weight. If the infected grain is first soaked and the scum skimmed off, hogs will usually eat the remainder without trouble. It is also possible to mix scabby barley with good barley, oats or corn in the proportion of 1 part diseased barley to 4 or 5 parts of other grains and feed the mixture to

hogs with no serious effect. Cattle, apparently, may be fed scabby barley alone or in a mixture with other grains.

The presence of more than 2 percent scabby kernels in barley used for malting reduces its value. Maltsters discount scabby barley heavily and pay a premium for scab-free barley. Scab reduces the germination and also liberates a substance which lowers the value of the malt.

Control of barley scab.—No methods are known which will insure a crop of barley free from scab. This situation is largely due to the wide distribution of the scab parasite and to the uncertainty of environmental conditions. There are certain methods, however, which are known to afford a considerable measure of control. They are as follows:

1. Use clean seed whenever possible. A test by the seed laboratory at Iowa State College will tell how much scab is present.
2. Fan all seed thoroughly to remove the light weight kernels. These are commonly diseased.
3. Treat the seed before planting with a chemical dust which will prevent seedling blight (see seed treatment).
4. Sow barley as early in the spring as possible to reduce seedling blights, hasten maturity of the crop and thus avoid serious scab injury.
5. Practice crop rotation so that barley will not follow crops heavily infested with the scab parasite. Avoid cornstalk land if possible, but if it is necessary to follow corn with barley, either remove the stalks, or plow them under before seeding barley. Barley does well after sugar beets, potatoes, or oats if the soil is fertile. Fertile soil which has grown soybeans should be satisfactory for barley. In many cases barley does well on clover sod. Drilling on plowed land is preferable to broadcasting. Rolling after sowing, when the soil is dry, increases germination.

Helminthosporium Blight, Spot Blotch or Root Rot

The organism which causes blight is undoubtedly as widespread as the scab organism. It is similar to scab in that it attacks the seed, seedling, roots and heads. In addition it causes a spotting of the leaves known as spot blotch. In 1931 and again in 1933 an abundance of blight developed in Iowa.

In mild or late cases of infection no shriveling or discoloration of the kernels is evident, but, when infection is severe, the diseased kernels are shriveled and dark brown at the base of the glumes. Sometimes the discoloration is almost black and extends well up on the back of the kernel. Spores of the fungus can usually be found by microscopic examination. On

moist blotters infected kernels often become covered with black spores, and the young roots become brown and withered. Blight-infected kernels may frequently be confused with those carrying scab.

On the growing roots in the field, a root rot frequently develops. This usually causes a gradual dying of the stems, leaves and heads giving to the plant a pale or whitish color. The root system in such cases is poorly developed and the heads have no grain. The symptoms of root rot are shown in fig. 3.

On the leaves (see fig. 4), yellowish brown spots appear fairly early in the season followed by an increase in severity as the season advances. The spots gradually become dark brown and have a whitish area in the center of each spot.

Fig. 3. Healthy and diseased barley plants. Those on right show the root rot disease.

It appears that blight is more prevalent and destructive on the heads at periods of high temperature and fairly low humidity. At such times the causal organism fruits abundantly on the chaff. The disease was unusually severe in 1933 and much of the seed for 1934 was infected. Traces of the disease may be found every year on seed barley.

Effect of blight on feeding and malting. —So far as known at present, barley infected with *Helminthosporium sativum,* which causes blight, root rot and spot blotch, does not in-

jure livestock. Its feeding value may be lowered but it is not poisonous. Blighted barley will not usually germinate as well or as uniformly as disease-free barley and for that reason is not desired by the malting trade.

Control of blight. Since the organism which causes blight attacks so many kinds of plants, including wheat, oats, rye, corn and many wild grasses, it is just as difficult to control as scab. In fact it is present every year on barley in Iowa either as a leaf spot or as a head blight. The most effective control measures are: (1) Secure seed as free from disease as possible, (2) treat the seed with an organic mercury dust (see seed treatment), (3) plant the crop early, and (4) practice rotation as described for scab control.

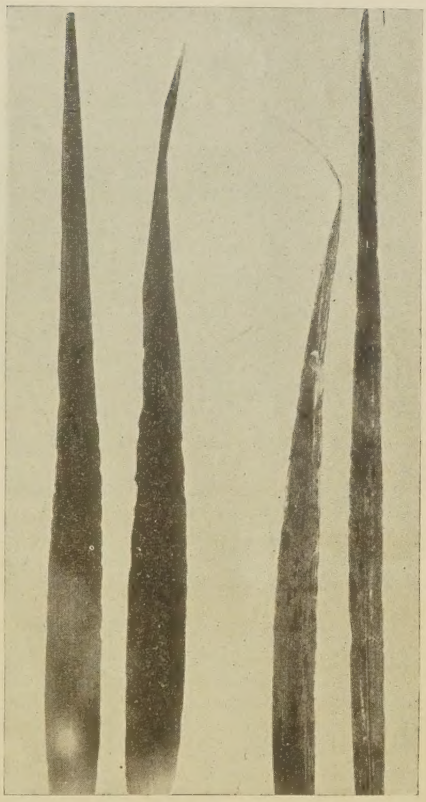

Fig. 4. Healthy and diseased barley leaves. Those on right show spot blotch.

Covered Smut

This disease may be detected in the field by the presence of black heads which are masses of smut spores that have displaced the normal kernels. Each mass is covered with a whitish membrane. The smut spores are not readily shattered by the wind except in the early stages of development. When the grain is ripe the smut masses usually become hard, although some smut spores may become scattered on healthy

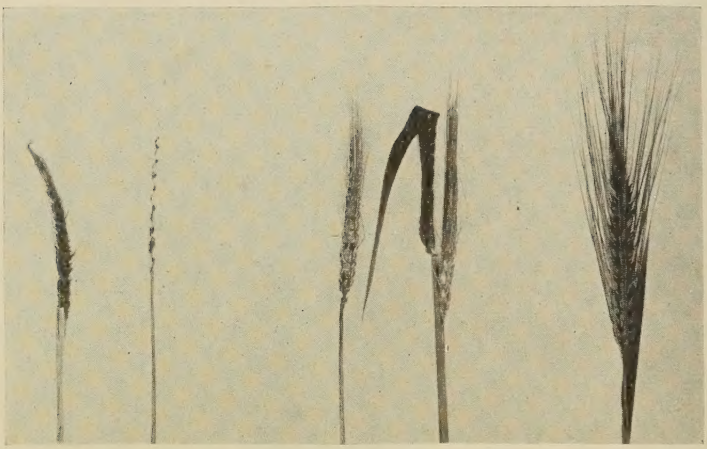

Fig. 5. Barley smuts. Left—loose, center—covered, right—healthy.

seed at threshing time. The presence of covered smut may be detected in threshed grain by the smut balls or by a laboratory test in the Iowa State College Seed Laboratory. ***Seed treatment with New Improved Ceresan, ½-ounce per bushel, will control covered smut.*** (See section on seed treatment.)

Loose Smut

Loose smut appears most abundantly when the grain is heading. It is found only in the heads, where it completely displaces the normal kernels with a black mass of smut spores. As the grain ripens the spores from the diseased heads are scattered, leaving nothing but a bare stalk where the smut masses were present. The spores of the loose smut organism infect the flowers of the healthy heads; the organism then grows inside the developing seed where it lies dormant until the following spring. As the infected kernel grows, the smut organism grows with it and replaces the normal kernels again in the head. ***The only control measure for one type of loose smut of barley is the modified hot water treatment.*** One type may be controlled by the same treatment described for covered smut. It is difficult to distinguish the two types of loose smut in the field. Symptoms of loose and covered smuts are shown in fig. 5.

Stripe Disease

Stripe of barley is more like a blight disease. It appears as long, yellowish brown stripes on the leaves and stems of infected plants which produce either badly shriveled heads or

no grain at all. In advanced stages the diseased plants become dull brown in color with ashen gray streaks or stripes on the leaves and stems. In some cases infected seeds produce weak, stunted plants which may die early, thus reducing the stand. Figures 6 and 7 show symptoms of stripe on barley plants and leaves. Stripe develops most when the soil is cold during the germination period. Seed from a given lot planted April 1 may produce a crop with 20 percent stripe whereas the same seed planted May 1 may produce a crop with only a trace of stripe. This does not necessarily mean that barley should be planted late, because such a practice will result in large losses from stem rust and scab. Early-planted barley usually gives a greater yield than late-planted barley. ***Stripe may be controlled by treating the seed with New Improved Ceresan, ½-ounce per bushel.*** (See section on seed treatment.)

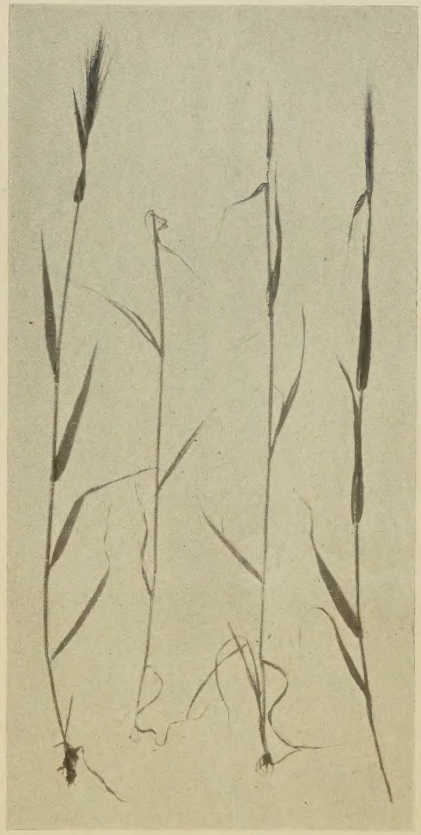

Fig. 6. Healthy and diseased barley plants. Three plants on right show stripe disease. Note lack of head in one and poorly developed heads in others.

Ergot

Ergot is readily identified by the presence of black, horny bodies, two or three times the size of a rye kernel, on the heads in place of normal grain kernels. These bodies project out well beyond the glumes and are readily seen on rye, barley,

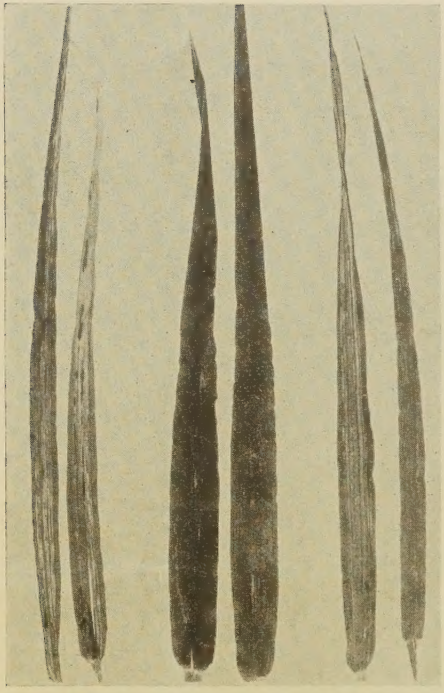

Fig. 7. Healthy and diseased leaves of barley. Left —stripe, center—healthy, right—bacterial blight.

quack grass and other grasses. The sclerotia or black bodies remain alive in the soil and are also carried in the seed. Large quantities of ergot fed to pregnant animals cause abortion. For control of ergot see "Diseases of Rye," page 19.

Bacterial Blight

This disease attacks the leaves and the glumes surrounding the kernels. It is also carried by the seed. On the leaves it causes both short and long streaks which are yellow or yellowish-brown in color. Frequently the infected leaves become shiny and glisten because of the streaks of bacteria which ooze to the leaf surface. The streaks are often confused with those of the stripe disease but the leaves do not dry and shred as readily as on stripe-diseased plants (see figs. 7 and 8). Furthermore, the heads do not shrivel so much, hence seed is usually produced by infected plants. Bacterial blight causes considerable loss in certain seasons. The most effective control measures are (1) to secure disease-free seed, and (2) to practice crop rotation.

Relation of Diseases to Market Grades

Probably no other factor has affected the standards for barley grades more than have diseases. Both scab and blight have to be considered by federal grain inspectors. Barley containing more than 4 percent blight is classed as *sample grade* and sells on the basis of the sample to any purchaser. Barley

containing 2 to 5 percent blight is classed as *blighted barley*. Higher grades must contain less than 2 percent blight. Both scab and Helminthosporium blight are considered a form of blight by the grain inspectors. Growers who wish to market premium or high quality barley must first know how to produce it.

Production of Premium Barley

Although the malting trade will pay a premium for high grade barley, farmers should avoid over-production because of (1) danger of reduced price, and (2) production of inferior grades by inexperienced producers. Those who are in the business may produce high quality barley by observing the requirements listed above, provided seasonal conditions are not too unfavorable. Groups of farmers may profitably club together, follow the rules for disease control and develop a business of marketing high quality barley. The Iowa State College Seed Laboratory can make tests of barley after threshing and determine if objectionable diseases are present. Barley which is relatively free from scab and blight will sell for a much higher price than diseased

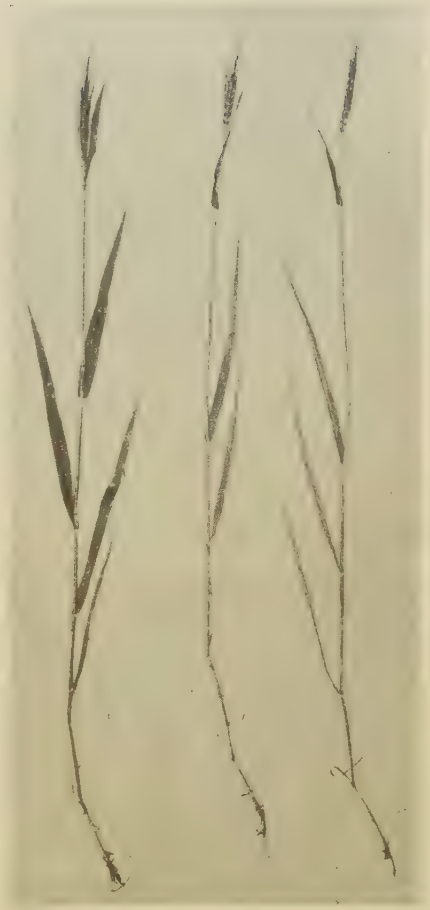

Fig. 8. Healthy and diseased barley plants. Plants on right show bacterial blight.

barley. Township groups which are producing barley should submit sale samples through the local elevator before making a final sale.

Varieties to Grow

Many commercial varieties of barley, both old and new, are available for sowing. Aside from certain local climatic and soil adaptations, the farmer should choose a variety best suited to his needs. Manchuria, Oderbrucker and Minsturdi are rough-awned varieties suitable either for feed or malting if free from scab. Trebi is a high-yielding, rough-awned variety of high feeding value but not desired by maltsters as a malting barley. Velvet, Glabron, Spartan, Wisconsin 37 and Wisconsin 38 are smooth-awned varieties valuable for feeding, but Velvet, Wisconsin 37 and Wisconsin 38 are preferred for malting. Glabron and Spartan are recognized as good pearling barleys. None of the above varieties is highly resistant to any or all of the diseases described except Wisconsin 38 which is resistant to stripe.

DISEASES OF OATS

Net returns per acre from oats are usually less than from either barley or winter wheat in Iowa. Low returns are in large part due to the low price received per bushel, but diseases also reduce the efficiency and thus increase the cost of production. The diseases of oats which are described in this circular are smuts, halo-blight, blast and seedling blights.

Fig. 9. Healthy and smutted oat heads. Left—healthy, center—covered smut, right (2 plants)—loose smut.

Fig. 10. Healthy and diseased oat panicles. The three plants to the right show different types of blast.

Oats Smuts

Smuts of oats occur wherever the crop is grown but the amount of damage they cause is dependent (1) on the amount of infection carried on the seed, and (2) on the temperature and moisture content of the soil when the seeds are germinating. Dry soils, with moderately low temperatures, encourage the infection of the kernels by the smut parasite. The parasite must be carried on the seed, however, in order to produce the disease.

There are two kinds of smut in oats, the loose and the covered, but for all practical purposes they are much the same. Oat smut expresses itself only in the heads, each kernel being replaced by a black mass of smut which may be more or less surrounded by a thin membrane. The smutted heads appear when the normal plants begin to head out but, as the season advances the smut powder scatters and is blown away, leaving only the skeleton of an oat head (see fig. 9). Oat smuts may be controlled by seed treatment using either formaldehyde or dusts (see seed treatment).

Halo-blight

This disease occurs every year on oats in Iowa but in some seasons it is much worse than in others. It is evident primarily on the leaves, but may be found on the chaff and leaf sheaths. On the leaves the disease appears first as a light green, small, oval spot which gradually increases in size until it may extend

Fig. 11. Wheat scab. Heads and kernels on right show symptoms of scab.

entirely across the leaf. The center of the spot remains brown or reddish but the surrounding tissue is yellow or yellowish green. Severely infected leaves may become constricted or narrowed wherever the lesions have developed. On old leaves all the spots may become gray brown and shrunken. The same weather conditions (cloudy and warm) which favor the spread of halo-blight also seem to increase head blast, one type of which is caused by the halo-blight organism. The cause of halo-blight is a bacterial organism which is carried by the seed but no practical seed treatment has been found that will completely control the disease.

Blast

Each year oats are troubled with a disease known as "blast" or "white head" but the cause of one type is not known. Part or all of the head may be affected as evidenced by the absence of normal kernels. The outer glumes or chaff appear white or blasted but contain no grain (see fig. 10). It is thought that weather conditions have some relationship to the disease,

but, since the causes are not definitely known, no control method has been developed.

Seedling Blights

The scab organism which is frequently severe on wheat and barley also attacks oats, causing dead kernels or kernels which develop weak plants that blight in the soil. Another organism which occurs commonly on oats is similar to the one which causes root rot, spot blotch and blight of barley. It infects the kernels and when germination starts, the seedlings either die or their growth is retarded. On young seedlings the roots frequently become decayed. Either the scab or the blight organism may thus reduce the stand and the yield when carried by seed oats. Tests in the Iowa State College Seed Laboratory show that germination may be improved and the yield increased by treating infected lots of oats with New Improved Ceresan which controls or reduces the action of these organisms. It is not uncommon to have the stand increased by 5 to 15 percent from seed treatment (see seed treatment).

DISEASES OF WHEAT

Among the different small grains grown in Iowa, wheat is second to oats in the number of acres planted annually. By far the larger portion of the wheat crop is winter wheat. Scab and stem rust have made spring wheat production a hazardous enterprise and even winter wheat production is frequently reduced materially by scab. Bunt or stinking smut and loose smut occur on both spring and winter wheats annually. The symptoms and control measures for each wheat disease are described below.

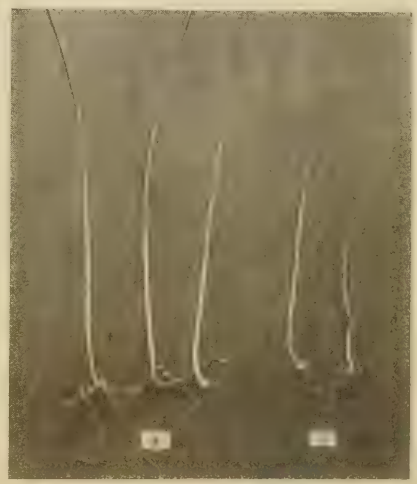

Fig. 12. Seedling blight of wheat. Left—healthy plants, right—diseased plants.

Scab

The serious effects of scab were observed in Iowa on wheat earlier than on barley, in fact, no one disease

has had more to do with the decline of spring wheat production than has scab. The disease occurred in epidemic form in 1918, 1928, 1932, and 1935. Its ravages were undoubtedly responsible in large measure for the displacement of spring wheat by oats in Iowa prior to the time when plant disease survey records were made.

Symptoms of scab on wheat are similar to those on barley, but they are more readily detected on the former crop. The seed, seedling and head are the parts infected. Diseased spikelets become shriveled, lose their green color and develop a pink or white crust of mold. On old heads which have stood in the shock, small black fruiting bodies appear on the chaff. Badly diseased kernels are white or pink, light in weight and spongy. Moderately infected kernels are usually shriveled.

Fig. 13. Stinking smut or bunt of wheat. Smutted heads and smut balls are shown on the right for comparison with healthy heads and kernels on the left.

Fig. 14. Healthy and smutted wheat heads. Two on right show loose smut.

Symptoms of scab on wheat heads, kernels and seedlings are shown in figs. 11 and 12.

No control measures are known which are capable of controlling scab. The methods described for barley should be followed, especially fanning and seed treatment (see page 5).

Stinking Smut

Stinking smut or bunt is a disease of wheat that occurs wherever wheat is grown. The symptoms on the heads are shown in fig. 13. Smut kernels are really masses of brown spores covered with a thin hull which is readily crushed between the fingers. Normal kernels are displaced by these smut balls which have an odor of dead herring. This odor taints flour made from smutty wheat, hence scouring of such wheat is necessary. This accounts for the dockage farmers receive when they sell smutty wheat. Records kept by the Grain Grading Division of the United States Department of Agriculture show that stinking smut has been increasing somewhat in Iowa. This condition is unnecessary because seed treatment and fanning are effective control measures.

The smut spores are carried to the soil with seed wheat and germinate with the wheat kernel. Any disinfectant which will

kill the smut spores without injury to the wheat kernels provides an effective remedy (see seed treatment).

Loose Smut

Loose smut of wheat, illustrated in fig. 14, is similar to one of the loose smuts of barley in that the spores from smutted heads scatter and lodge on healthy heads at blossoming time. These spores germinate and enter the developing kernels in which they remain dormant until the next season. As the infected wheat kernels sprout, the smut parasite begins to grow and continues inside the stem, becoming localized in the head before it emerges. Each wheat kernel is displaced by a mass of smut spores which ripens and scatters before healthy heads are mature. Seed treatment with hot water is the only known method of control for loose smut (see page 21).

Other Diseases of Wheat

Less destructive and less easily recognized diseases of wheat than those described above are black chaff, Septoria leaf spot, powdery mildew, root rot and ergot. Black chaff is a bacterial disease which causes black stripes on the chaff and at the base of the head. No satisfactory control measure is known. Septoria leaf spot and mildew both are leaf parasites and do considerable damage in some seasons. Ergot is not common on wheat and may be considered of no economic importance.

Fig. 15. Healthy and diseased heads of rye. Note ergot masses in head on the right.

DISEASES OF RYE

Both winter and spring rye are grown in Iowa, the former being used as a crop on land infested with perennial weeds after a summer of bare fallowing. Ergot is probably the most common disease, but stem smut and scab are frequently found.

Ergot is readily detected by the presence of black, horny bodies, two or three times the size of a rye kernel, on heads in place of normal kernels (see fig. 15). These bodies project out well beyond the chaff where flies frequently gather. These black bodies remain alive in the soil and are also carried in rye seed. Small quantities of ergot fed to pregnant animals may cause abortion. Ergot may be controlled by: (1) frequent mowing to prevent heading of wild grasses near the grain fields, (2) plowing infested land before reseeding, and (3) soaking the seed in salt brine made up at the rate of 40 pounds of salt in 25 gallons of water. If the grain is stirred, the black bodies will rise to the top and may be skimmed off. The seed should then be rinsed in cold water, dried and sown as soon as possible.

Stem smut attacks the heads and stems of rye, causing broken stems and heads with no grain. Control is readily accomplished by seed treatment with copper carbonate (see page 20).

For a discussion of scab, see barley and wheat.

SEED TREATMENTS

Before any small grain is treated for diseases, it should be thoroughly fanned to remove weed seeds, smut balls and other diseased kernels. The following materials may be used for the control of certain seed-borne diseases.

1. New Improved Ceresan

This is a new product for seed treatment. It contains a different mercury compound than the old Ceresan and since the percentage of active mercury is higher than in the old, much less dust is required per bushel.

New Improved Ceresan has been tried experimentally by the Botany and Plant Pathology Section of the Iowa Agricultural Experiment Station for 3 years on small seed lots. The seed laboratory has used this dust extensively on oats, barley, and flax in the laboratory and in the field. The extension plant pathologists have used it 3 years on oats, barley and flax on a field basis. It apparently is satisfactory to use on barley for the control of covered smut, stripe and seedling blights, on oats for seedling blight and smut control and on wheat for control of stinking smut and seedling blights. The cost of the new dust, if purchased in quantity, is less than 2 cents per bushel.

Fig. 16. A homemade seed treatment machine in operation.

In 1933 twenty lots of farmers' seed barley were divided into two portions, one treated, the other kept as a check. Each portion was planted in steamed soil in the laboratory and also in the field. The average percentage germination in the laboratory was 87 for the treated and 79 for the check. Field results were 81 for the treated and 70 for the check. Similar tests were then made with five varieties which included Colsess, Spartan, Glabron, Velvet and Minsturdi. The laboratory germinations gave an average of 85 for the treated samples and 63 for the check (see cover illustration). Results in the field were 76 for the treated and 59 for the check. Laboratory germinations on 60 farmers' lots of barley in 1934 gave 89 percent for the treated and 79 for the check. The average yield increase on the five varieties due to treatment in 1933 was 4.4 bushels per acre.

In 1934 this dust practically eliminated smut on 60 different farmers' lots of oats. In one test with 20 lots, 400 rows were planted with treated seed representing 20 rows for each lot and smut occurred in only 4 out of the 400 to the extent of one smutted plant per row. In the 400 rows planted with seed not treated there were 2,466 smutted plants. One lot showed an average of 28 smutted plants per 15-foot row.

In the above test the treated samples gave an average yield of 22.9 bushels per acre and the untreated 20.9 bushels, showing a gain of 2 bushels per acre. The percentage gain in yield was 9.3 for the entire plot due to seed treatment. The highest increase on any sample was 5.3 bushels when the yield of the untreated sample was 20.5 bushels per acre. On 2 lots out of the 20, no increase was secured. The yields per acre were low because of the drouth.

It is absolutely necessary that this product be used according to directions on the can, namely ½-ounce per bushel, otherwise the seed may be killed. Each can has a measuring cup which, when level-full, holds ½-ounce. Use this full and no more on each measured bushel of grain. A seed treatment machine or a cement mixer may be used to apply the dust. ***The grain should be thoroughly mixed with the dust*** and may be applied several weeks before the grain is sown.

2. Copper Carbonate and Copper Carb

Either of these dusts used at the rate of 2 to 3 ounces per bushel will control stinking smut of wheat, smuts of hulless oats, covered smut and stripe of hulless barley, stem smut of rye, kernel smuts of sorghum and the kernel smut of millet. This dust should not be used on common oats and barley—only on hulless varieties.

3. Formaldehyde

Liquid formaldehyde used at the rate of 1 pint to 5 or 10 gallons of water sprinkled on 50 bushels of oats will control the smuts of oats. ***It should never be used on hulless oats or hulless barley.*** This treatment is cheaper than any of the dusts but it gives less increase in yield and may lower the germination. It is best not to use formaldehyde on wheat or rye. Oats may be treated 1 or 2 days before seeding, either on the floor of the grain bin or in the wagon box. A sprinkling can or knapsack sprayer may be used to apply the solution, after which the grain should be covered for 4 hours or over night.

4. Modified Hot Water

The loose smut of wheat and one of the loose smuts of barley can be controlled by treating infected seed in hot water. The method is laborious, it requires an accurate thermometer, it often reduces the germination and therefore is not recommended for large lots of barley or wheat. The best system is to treat enough seed for 2 to 5 acres, plant it away from other grains of the same kind and save the crop for seed purposes the following year. The method in detail is given below:

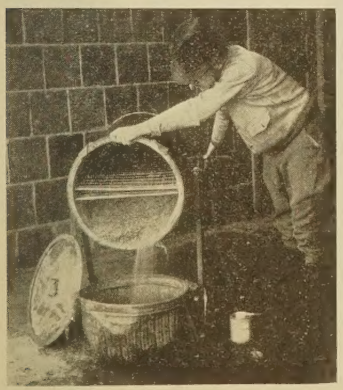

Fig. 17. A barrel mixer for treating small quantities of cereal grains.

a. Place the cleaned seed in burlap sacks each containing not more than one-half bushel.

b. Soak the grain 4 hours in cold water.

c. Remove the sacks from the cold water and place in water at 115° to 120° F. for 2 minutes.

d. Soak the seed in a third bath of water held at 126° F. for barley (13 minutes) and 129° F. for wheat (10 minutes). The temperature may be maintained by steam or by building a fire under a large oil barrel.

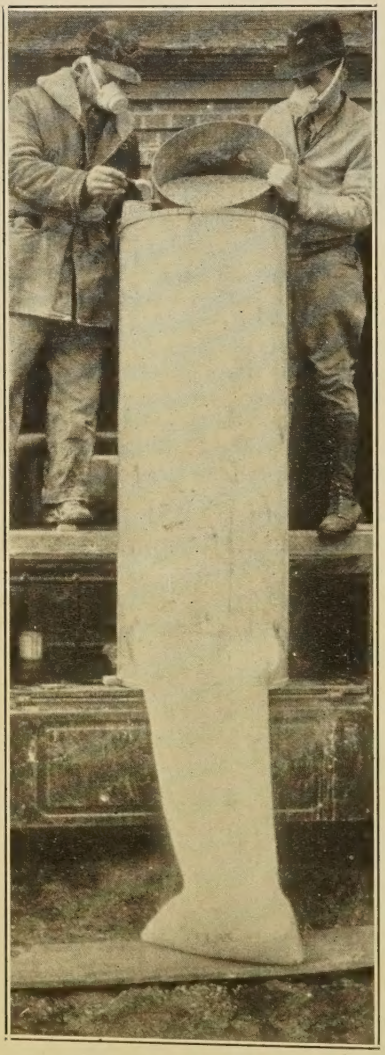

Fig. 18. A gravity machine for treating quantities of cereal grains.

e. After the final bath dip the grain for a few seconds in cold water, spread out to dry, and sow as soon as the grain will run through the drill or seeder.

The rate of seeding should be increased at least by one-fourth above normal for grain treated with hot water because of injury to germination. If the drill is regulated to allow twice the normal amount of seed to drop, this method will prove satisfactory for seeding barley or wheat.

WHEN AND HOW TO TREAT SEED

1. Grain may be treated whenever any of the controllable diseases herein described are found in the grain field.

2. When using any of the dusts, it is best to use a dust mask, sponge or handkerchief over the nose to prevent inhaling the chemicals.

3. If New Improved Ceresan or other mercury dusts are used on oats and barley, the treatment should be made at least 2 days before the grain is sown, but the grain may be treated several weeks before seeding if kept in a dry bin.

4. A large barrel churn or a special drum mixer may be used to treat grain. A homemade mixer can easily be made by running a gas pipe diagonally through a 55-gallon oil

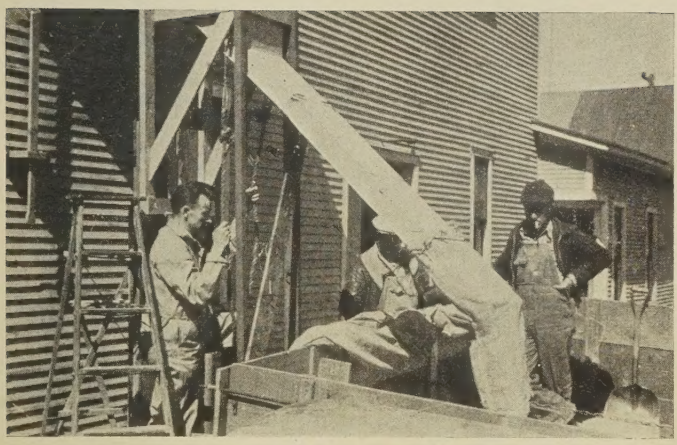

Fig. 19. A large capacity gravity machine for use in grain elevators.

barrel. Braze the pipe in, put a crank on each end of the pipe, provide a hinged door at one end of the barrel, then mount the outfit on two wooden horses. Two men with such a machine can treat at least 25 bushels of grain per hour.

5. Some grain elevators have large seed treatment machines which will treat large quantities of grain per hour. At least three commercial concerns have machines on the market which could be used by grain elevators to establish seed treatment centers.

Four types of seed treatment machines are shown in figs. 16 to 19, inclusive. Further information on machines may be secured by writing the Extension Service of Iowa State College.

Cooperative Extension Work in Agriculture and Home Economics, Iowa State College of Agriculture and Mechanic Arts and the United States Department of Agriculture Cooperating. R. K. Bliss, Director, Ames, Iowa.
Issued in furtherance of the acts of Congress of May 8 and June 30, 1914.